

We claim:

1. An apparatus for monitoring the protraction of a seat belt from a seat belt retractor under crash induced loads, the apparatus comprising:
  - a seat belt retractor having at least one deformable structure that deforms in response to protraction of the seat belt, with the at least one deformable structure being at least in part ferromagnetic;
  - a magnetostrictive sensor positioned to receive electromagnetic signals from the at least one deformable structure when said at least one deformable structure undergoes strain; and
  - a motor vehicle safety system in signal receiving relation to the magnetostrictive sensor.
2. The apparatus of claim 1 wherein the at least one deformable structure is a torsion rod which defines an axis and to which a seat belt webbing spool is mounted.
3. The apparatus of claim 2 wherein the magnetostrictive sensor is positioned axially spaced from the torsion rod.
4. The apparatus of claim 2 wherein the magnetostrictive sensor is a coil placed around a portion of the torsion rod.
5. The apparatus of claim 1 wherein the magnetostrictive sensor has a sensing coil and a permanent magnet so that the magnetostrictive sensor is of the passive type.
6. The apparatus of claim 1 wherein the magnetostrictive sensor has a first active coil and a second passive coil that are both positioned about a ferromagnetic element.

7. The apparatus of claim 6 wherein the ferromagnetic element is a torsion rod which forms the at least one deformable structure.

8. A method of monitoring the protraction of a seat belt from a seat belt load limiter in which the seat belt is mounted to a deformable load limiting structure which is at least partly ferromagnetic, so the structure deforms in an energy absorbing manner as a quantity of seat belt webbing is protracted, the method comprising the step of: monitoring with a motor vehicle safety system an output of an electrical coil positioned adjacent or about the deformable load limiting structure which is at least partially ferromagnetic.

9. The method of claim 8 wherein the step of monitoring with a motor vehicle safety system includes positioning a magnet adjacent the electrical coil.

10. The method of claim 8 wherein the deformable load limiting structure is a ferromagnetic torsion rod, and wherein the step of monitoring with a motor vehicle safety system further comprises placing adjacent or about the ferromagnetic torsion rod a permanent magnet, and the ferromagnetic torsion rod having portions about which at least one magnetic coil is wound.

11. The method of claim 8 further comprising the step of notifying an operator of a motor vehicle that the deformable load limiting structure has undergone plastic yielding.

12. The method of claim 8 further comprising the step of controlling the deployment of an airbag based on the output of the electrical coil as processed by the motor vehicle safety system.

13. The method of claim 8 further comprising the steps of generating an electromagnetic field to cause vibration of the deformable load limiting

structure, and monitoring with the electric coil the resulting caused vibration in the load limiting structure.

14. An apparatus for monitoring the strain in a load limiting structure which absorbs energy as a seat belt is protracted, the apparatus comprising:  
at least one deformable structure which deforms in response to protraction of the seat belt, wherein the at least one deformable structure is at least in part ferromagnetic;

a magnetostrictive sensor positioned to receive electromagnetic signals from the at least one deformable structure when said at least one deformable structure undergoes strain;

a motor vehicle safety system in signal receiving relation to the magnetostrictive sensor.

15. The apparatus of claim 14 wherein the at least one deformable structure is a torsion rod to which is mounted a spool upon which a quantity of seat belt webbing is wound.

16. The apparatus of claim 14 wherein the magnetostrictive sensor is positioned axially spaced from the torsion rod.

17. The apparatus of claim 15 wherein the magnetostrictive sensor is a coil placed around a portion of the torsion rod.

18. The apparatus of claim 14 wherein the magnetostrictive sensor has a sensing coil and permanent magnet and is of the passive type.

19. The apparatus of claim 14 wherein the magnetostrictive sensor has a first active coil, and a second passive coil which are both positioned about the at least one deformable structure.

20. A method of monitoring the protraction of a seat belt from a seat belt load limiter in which the seat belt is mounted to a deformable load limiting structure which is at least partly ferromagnetic, so the structure deforms in an energy absorbing manner as a quantity of seat belt webbing is protracted, the method comprising the step of: monitoring with a motor vehicle safety system an output of an electrical coil positioned adjacent or about the deformable load limiting structure which is at least partially ferromagnetic.